

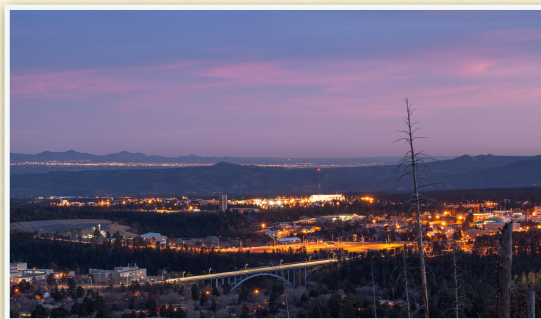
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# PRECISION JET PHYSICS IN ELECTRON-PROTON COLLISIONS

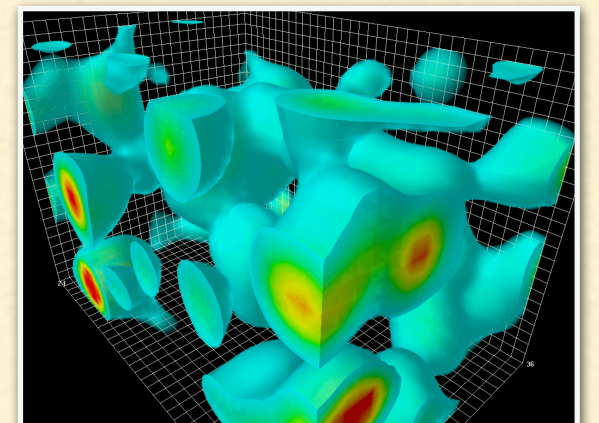
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**Christopher Lee**  
LANL

Based on work with Daekyoung Kang and Iain Stewart  
PRD 88, 054004 (2013) [arXiv:1303.6952],  
arXiv:1404.6706, and work in progress



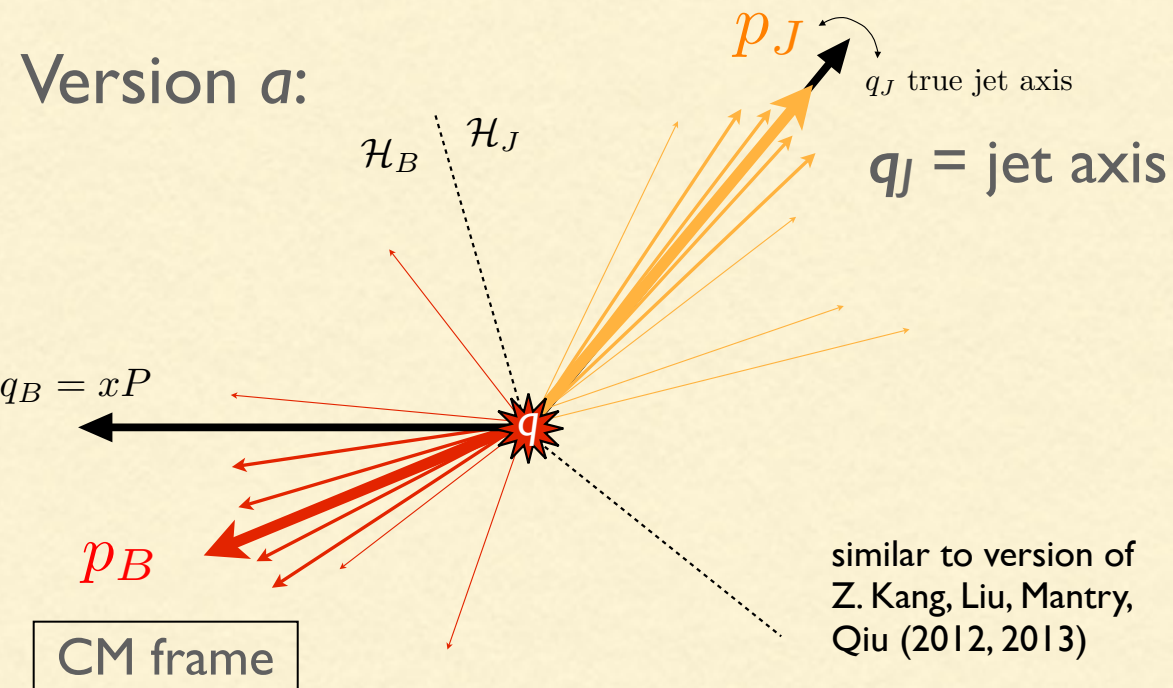
Town Meeting on QCD  
September 14, 2014



# EVENT SHAPES IN DIS:

D. Kang, CL, Stewart (2013, 2014)

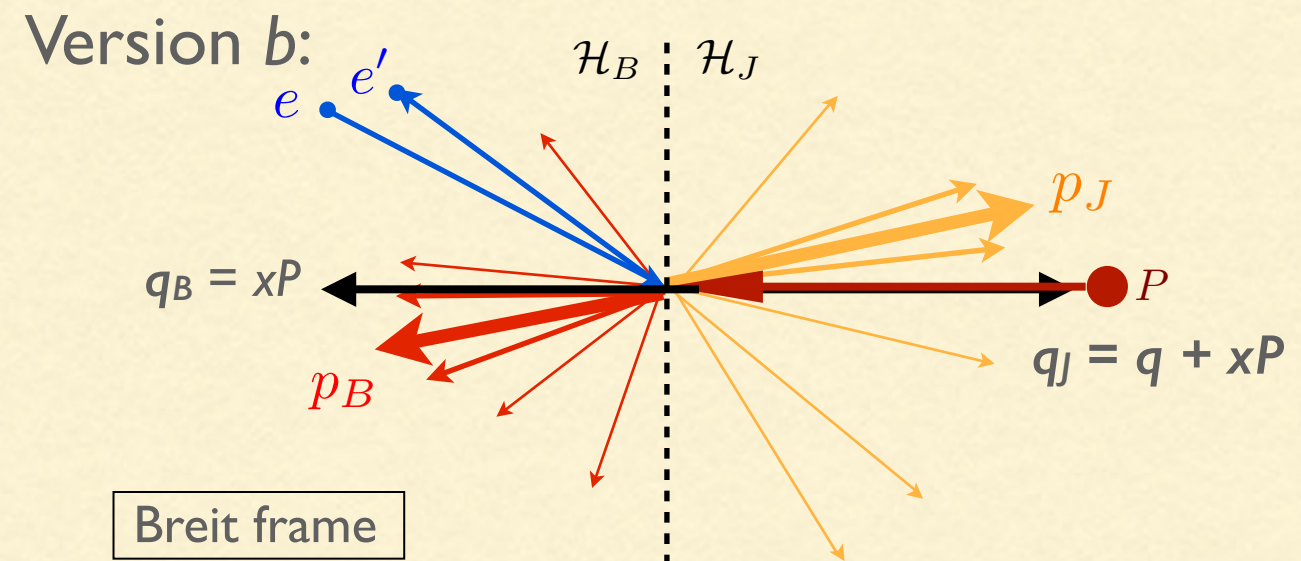
- “I-jettiness” (or thrust) in DIS probes final states with beam radiation + one additional jet



SCET factorization in small  $\tau$  region:

$$\frac{1}{\sigma_0} \frac{d\sigma(x, Q^2)}{d\tau_1^a} = H(Q^2, \mu) \int dt_J dt_B dk_S \delta\left(\tau_1^a - \frac{t_J}{Q^2} - \frac{t_B}{Q^2} - \frac{k_S}{Q}\right) \times J_q(t_J, \mu) B_q(t_B, x, \mu) S(k_S, \mu)$$

- Averages over ISR transverse momentum
- Resummation to NNLL and N<sup>3</sup>LL  
Z. Kang, Liu, Mantry, Qiu (2013); D. Kang, CL, Stewart (2013, 2014)
- Computed fixed-order  $\mathcal{O}(\alpha_s)$  numerically  
Z. Kang, Liu, Mantry, Qiu (2013)



same as “DIS thrust”  
(can be measured solely from “current” hemisphere  $\mathcal{H}_J$ )

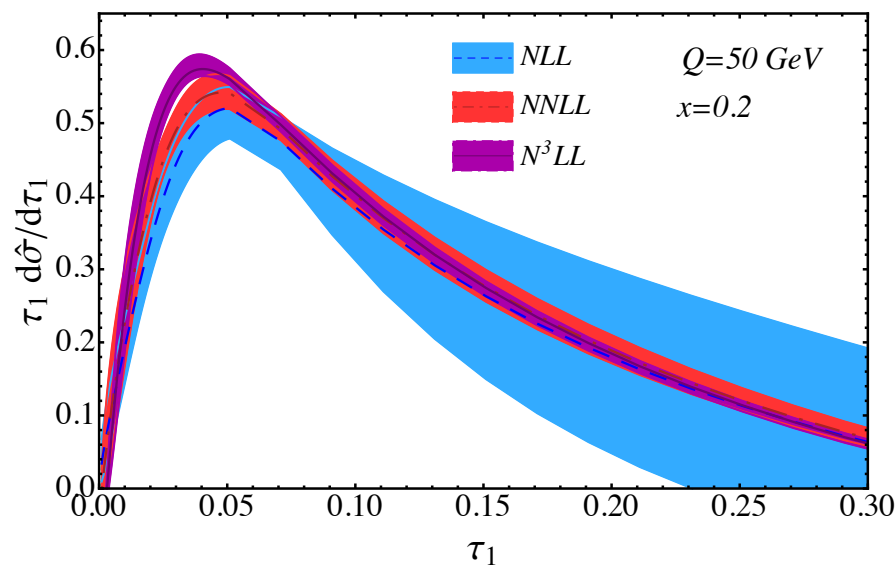
$$\frac{1}{\sigma_0} \frac{d\sigma(x, Q^2)}{d\tau_1^b} = H(Q^2, \mu) \int d^2p_\perp dt_J dt_B dk_S \delta\left(\tau_1^b - \frac{t_J}{Q^2} - \frac{t_B}{Q^2} - \frac{k_S}{Q}\right) \times J_q(t_J - \mathbf{p}_\perp^2, \mu) \mathcal{B}_q(t_B, x, \mathbf{p}_\perp^2, \mu) S(k_S, \mu)$$

- Sensitive to ISR transverse momentum
- Resummation to NNLL (& appx. N<sup>3</sup>LL)  
D. Kang, CL, Stewart (2013, 2014)
- Computed fixed-order  $\mathcal{O}(\alpha_s)$  analytically  
D. Kang, CL, Stewart (2014)

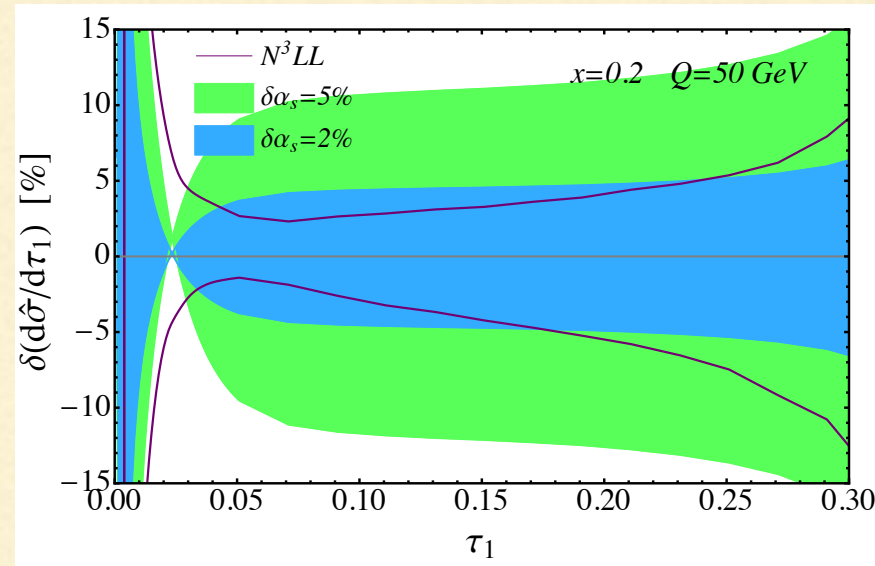


# PERTURBATIVE AND NONPERTURBATIVE EFFECTS

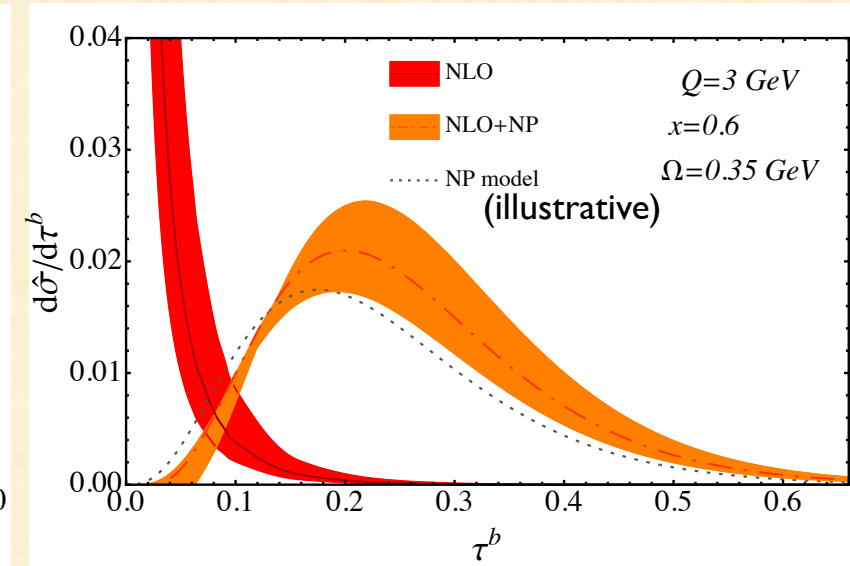
D. Kang, CL, I. Stewart (2014)



**$N^3LL$  resummed PT prediction at EIC**  
highest resummed accuracy  
for DIS event shapes, previously NLL

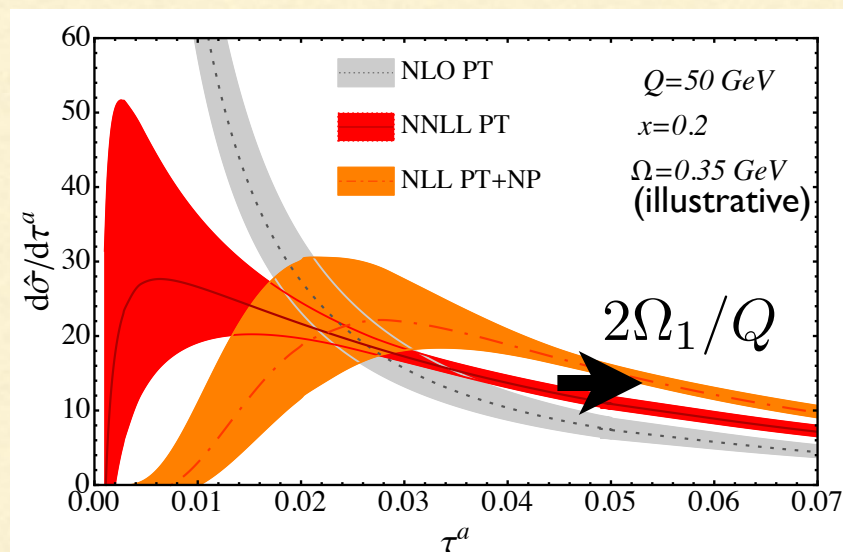


**Sensitivity to strong coupling**  
from one distribution at fixed  $x, Q$ ;  
expect improvement from multiple  $x, Q$ :  
<1% level precision



**NP shape function convolved with NLO PT at JLab 12**  
Shape function should be independent of  $x, Q$ ;  
better measured at low  $Q$

- For large enough  $Q$ , leading NP effect in the PT distribution tail is a **universal shift**



at EIC

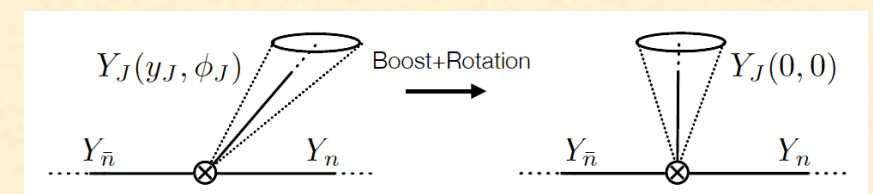
Using factorization theorems and  
boost invariance properties of soft  
Wilson lines, can prove that:

$$\Omega_1^a = \Omega_1^b = \Omega_1^c$$

("c" = hemisphere thrust in CM frame)

D. Kang, CL, I. Stewart (2013)

Same  $\Omega_1$  even appears as leading soft  
NP correction to jet mass at **LHC!**



Stewart, Tackmann,  
Waalewijn (2014)

